Local Temperature in Gastric Hypothermia

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■ *Measurements of temperatures inside the stomachs of humans by means of thermister probes introduced with the balloon used in cryotherapy indicated that the mucosa does not undergo freezing in this procedure.*

REPORTS by two groups of investigators on the local effects of gastric "freezing" appear to be in conflict. Wangensteen and coworkers[4] said that in humans the formation of ulcers in the stomach following the refrigerating procedure is uncommon. Lippman and associates[2] reported that when the same techniques were used in dogs, ulcer formation soon afterward is a common occurrence.

In the studies on which the foregoing reports were based, the temperature of the stomach was not known; it was merely assumed to be somewhere near the temperature of the cooling agent. To resolve the apparent conflict in observed results, more accurate measurement of the temperature of the stomach, preferably at various places on the mucosa, is needed. Hence a study was carried out to determine by direct means the local temperatures in the stomach when a coolant is circulated through a balloon that is expanded to fill the organ.

To this end, thermister probes placed in various positions were introduced simultaneously with the balloon in the hypothermia treatment of 44 patients who had duodenal ulcer. A Swenko gastric hypothermia machine was used to circulate the coolant, the temperature of which was −15° to −24°C as it was pumped into the stomach and −9° to −14°C as it emerged. The duration of treatment was from 45 to 60 minutes. The technique was that recommended by Peters and Wangensteen,[3] with the following modifications: Cetacaine spray instead of xylocaine gargle was used for local anesthesia of the throat. Meperidine, 50 mg, and atropine, 0.4 mg, were used as pre-medication. The balloon used was stomach-shaped.

To determine the positions of random-placed probes and the balloon in relation to the inner lining of the stomach, 60 cc of a contrast medium (Hypaque®) was introduced through a Levine tube into the stomach after the balloon was inflated as usual with an alcohol coolant. Three x-ray views taken of the abdomen showed the position of the balloon and of the probes (Figures 1, 2 and 3).

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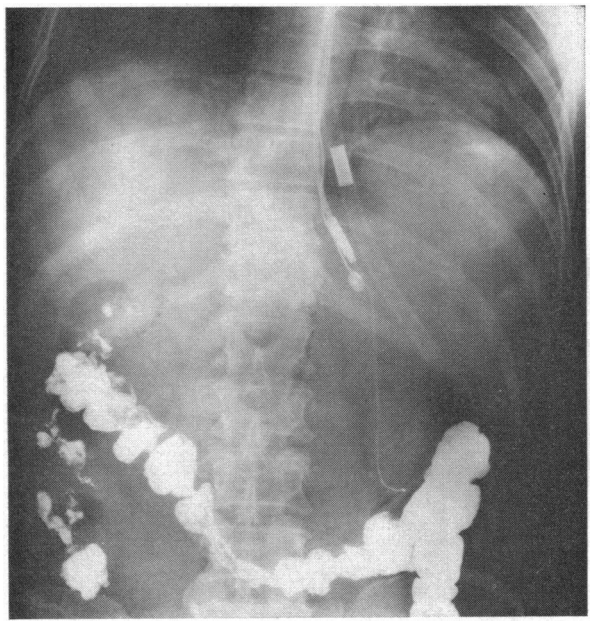

Figure 1.—Intragastric balloon filled with ethanol. Coaxial tube appears near level of lower ribs on left side. Two temperature probes are noted, one near lesser curvature, the other near the greater curvature. Barium from recent upper gastrointestinal series is noted in colon.

The flow rate of the coolant was also measured. It was nearly the same in all cases. This factor becomes important when comparing observations with those of other investigators. Moreover, the flow rate was measured with the balloon outside and again with it inside the stomach. In both situations the rate was one liter of alcohol at −10°C in 40 seconds ± 2 seconds.

The tube through which the coolant was pumped into the balloon was tipped with a nozzle that had multiple side perforations and a blocked distal end. Concentrated ethanol served as the coolant. A standardized Yellow-Spring thermister electrothermometer recorded the temperatures of the probes.

The 44 patients were of four classifications, distinguished as follows:

Group I (12 cases). Probe taped to balloon to lie on greater curvature.

Group II (4 cases). Two probes attached to balloon; one near tip, one on greater curvature.

Group III (24 cases). Random placement of thermister probe.

Group IV (8 cases). Mucosal inspection by gastroscope before and after treatment. (Four of the patients in this group were also in one of the other three groups. Four were not.)

The temperatures recorded at the probes were as follows:

Group I. Average probe temperature was +7°C. Range was from +11°C to +4°C.

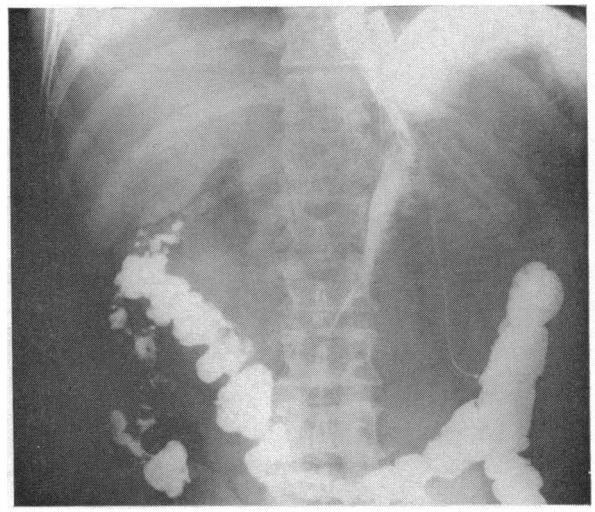

Figure 2.—Instillation of Hypaque® revealed what appeared to be air spaces near fundus and lesser curvature.

Group II. No recording was below +3°C. The greatest difference in any one case between one probe and another was 4°C.

Group III. Average probe temperature was +9°C. The lowest recorded temperature was +5°C.

Wangensteen recommended that on completion of the "freezing" treatment 5 minutes be allowed for ice crystals to melt and the balloon to separate from the wall of the stomach. Since the temperature recordings in the present study indicated freezing did not occur, we removed the balloon immediately after it was emptied of coolant. To find out what effect immediate withdrawal might have on the stomach mucosa, a Hirschowitz fiberoptic gastroscope was used in eight cases (Group IV) and no area of denudation or ulceration was seen in any of them. Hyperemia was noted in two cases and petechia in two.

X-ray films of the balloon-filled stomach with Hypaque as a contrast medium showed air in the cardia in some cases (Figure 3). The probes were visualized in a layer of Hypaque about 4 mm thick surrounding the balloon. In some instances the point of the probe was directed toward the mucosa, in some toward the balloon. As there was a liquid filled "buffer" zone between the balloon and the mucosa, it seems probable that the temperature of the mucosa was somewhat higher than the temperature recorded by the probes.

In some cases there was blood on the balloon when it was withdrawn, which at first was interpreted as due to continuing "freezing" for too long a time. On review of the cases in question, however, it appeared that blood on the balloon was more strongly related to a history of hemorrhage or gastritis than to long continued low temperatures.

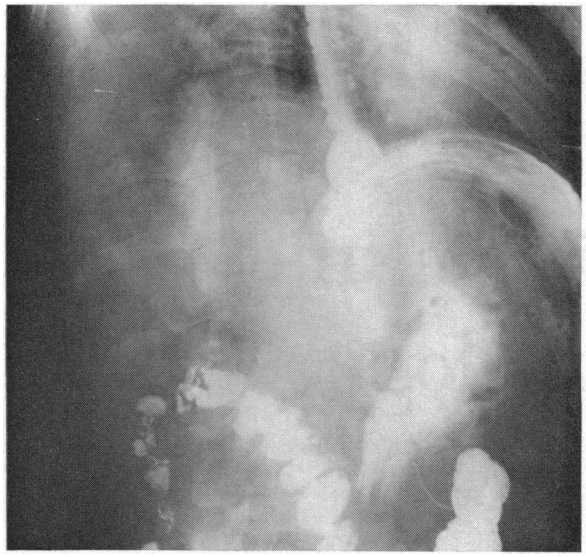

Figure 3.—Lateral view, functioning pyloris is faintly visible. Distribution of Hypaque® over balloon was apparently not even.

Discussion

From the temperature recording of probes pressed against the gastric mucosa it appears that the term *gastric freeze* used in connection with the procedure described is a misnomer. More generally and more correctly it should be *gastric hypothermia* or *gastric cryotherapy*.

Five factors related to ulcer formation in dogs after their stomachs were "frozen" are listed by Lippman:[2] (1) Flow rate of coolant; (2) degree and duration of cold; (3) size of stomach and thickness of stomach wall; (4) intragastric position of tip of inflow apparatus and the force of the stream; and (5) nature and thickness of the material used for the gastric balloon. Other important factors that should be taken into consideration are the size of the animal or patient, the level of anesthesia during treatment, the type and amount of premedication, and the amount of coolant used related to distensibility of stomach.

The stomach is a very good heat exchanger, as is shown by the often recorded wide differences between the temperature of coolant as it is introduced and the temperature when withdrawn, the average difference being about 7°C. Calories are removed by this process, and the core temperature of the body (as measured rectally) is lowered. The size of the subject and the volume of blood in relation to the amount and temperature of coolant, therefore, become critical factors in determining gastric mucosal temperatures.

Intragastric cooling was first suggested in England to obtain general body hypothermia for hyperpyrexic children.[1] Shivering, which is a mechanism for warming, is eliminated by general anesthesia. Gastric hypothermia in dogs is always accomplished under a general anesthetic. An anesthetized animal, however, does not shiver. In humans a general anesthetic is never used in connection with gastric cryotherapy and most patients shiver before the treatment is completed.

Distensibility of the stomach is another vital factor. Conceivably the stomach will cool much more rapidly when stretched. Again a difference in dog experiments and human treatment is evident. The dogs are under anesthesia and the stomach is inflated by chance and by guess. In humans the stomach is inflated to a point of fullness but short of pain, the patient being awake and able to guide the therapist.

Conclusions drawn from gastric hypothermia experiments in dogs cannot be applied to human gastric cryotherapy because of the wide differences in subjects. There is another great barrier to comparisons: Dogs do not get peptic ulcers spontaneously.

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